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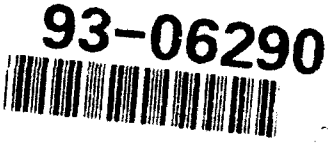
Information Technology: A Force for Organizational Change

Captain
William R. Bowen
U. S. Coast Guard

Faculty Research Advisor
Dr. Steve Knode

The Industrial College of the Armed Forces
National Defense University
Fort McNair, Washington, D.C. 20319-6000



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INFORMATION TECHNOLOGY;
A FORCE FOR ORGANIZATIONAL CHANGE

CAPT WILLIAM R. BOWEN, USCG

Information Technology is changing the face of the world as we know it. Business use of technologies like Decision Support Systems and Electronic Data Interchange allow organizations to re-engineer their processes to eliminate unnecessary layers of management. New emerging technologies under the umbrella of Artificial Intelligence are helping us to replace the human being with computer technology that simulates expert advice or learns as it matures. To take advantage of these new technologies requires new organization structures and new ways of approaching problem solving. This paper explores these new technologies and relates them to organizational change.

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"What is happening now is nothing less than a global revolution...In the years just ahead startling new institutions will replace our unworkable, oppressive, and obsolete integrational structures."

Alvin Toffler, The Third Wave

The world is changing at a dizzying pace. No where is that change more evident than in the information technology arena. Organizations as we know them are in peril. In the private sector, managers are using powerful information technology resources to reshape and retool their structures. In the public sector, declining sources of revenue and increased pressure to deliver more services for less money are combining to cause public bureaucracies to rethink their strategies for survival.

Organizational restructuring is neither new or unique. Organizations have long reorganized, changed business practices so that they may survive. What is different today is the role that information technology is playing in this arena. Futurist Marvin Cetron puts it this way,

"Decision processes, management structure, and modes of work are being transformed as businesses take the first steps from using unprocessed data to using information (data that have been analyzed, synthesized and organized in a useful way (Cetron, American Renaissance)."

This paper is about the role of information technology in today's organizations and how information technology can assist managers in navigating the uncharted waters ahead. In particular, the use of Electronic Data Interchange (EDI) and Decision Support Systems (DSS) will be explored to demonstrate how they offer new opportunities to restructure organizations to make processes more efficient and decision making more efficient.

No manager is exempt from the need to make quality decisions. From the Oval Office President of the United States to the owner of a small business, decisions are made on the strength or weakness of information. The noted Presidential historian Alexander George has written at length about "quality decisions," decisions made under conditions of uncertainty, without adequate information. In the realm of national security issues, a high quality decision yields a substantial benefit for the nation; but a poor decision can mean more than the loss of a few dollars at the margin. The difference between the two can be having the right information at the right time.

The information industry has virtually exploded in front of our eyes. Most organizations, both public and private, have attempted to keep pace with this explosion by acquiring information technology and sub-organizations to acquire and operate it. It has only been recently that information technology hardware and software have reached a point where information

systems can yield instantaneous information, arrayed in formats that allow decision makers to test their decisions in unique environments. As John Naisbett and Patricia Aburdene warn us in Megatrends 2000, "Without a structure, a frame of reference, the vast amount of information that comes your way each day will probably whiz right by you (Naisbett, p. 13)." There are structures and frameworks that can help, but these new systems can only be effective within the context of new organization structures.

Three relatively new concepts combine to place this capability at the fingertips of decision makers. Two of these are information technology related while the third is a new spin-off to a 1950s management style. These concepts are:

1. Computer-based Decision Support Systems or DSS.
2. Electronic Data Interchange or EDI. and
3. Organization Renewal, Re-engineering and Total Quality Management or TQM.

In this information age, these three concepts are increasingly inter-related. I will investigate each of these concepts and show how one organization, the U.S. Coast Guard, can use the two information technologies, coupled with an aggressive TQM/organization renewal program to provide a quantum leap in decision making capability.

THE NEW GENERATION OF DECISION SUPPORT SYSTEMS

There is an old saying that "art imitates life," or vice versa that "life imitates art." For example, in the 1960's, we watched Star Trek episodes where, on the bridge of the fictitious U.S.S. Enterprise, CAPT Jim Kirk, faced with a dilemma of life and death proportions, would consult a computer based information system for data. The data was provided in exactly the right format for the Captain to weigh, inside his head, the options available, then make a lightning quick decision. In these early episodes we saw data-based information systems at work.

A "generation" later, a new Enterprise with a new Captain, makes use of interactive computer processing and artificial intelligence (AI) which permits the decision maker to use "expert" capability to assist in making the decision. A "Holodeck" allows Captain Jean Luc Picard to simulate entire scenarios which permit the him to "try out" his decisions; to see how good the fit is.

The reason Captain Kirk did not make use of the kind of decision support systems (DSS) that exist today, the kind that help today's corporate executive or public official make decisions that are typically less than life or death, was that the futurists of the 1960s did not have 1990s systems to model their fictional systems after. Today's executive decision maker has

better tools available to him than that of our fictitious CAPT Kirk operating in the 22nd Century.

When Gene Roddenbury created Star Trek, he and his writers certainly envisioned computers being able to store, synthesize and retrieve huge volumes of information. What the original TV series did not foresee was the kind of system which is now available to take this same data and assist the decision maker in interpreting alternatives, weighing choices, and providing real decision support, not just data. So it is that we see CAPT Jean Luc Picard using a DSS that is based on the technology of today. Art imitating reality.

We have been making decisions for years without the aid of a computer-based DSS. Like the CAPT Kirk of lore, we have been making those decisions by assembling huge quantities of information, then processing the information into a format the decision maker can understand and utilize. The promise of today's DSS is the quantum leap in computer-based systems we have been waiting for. We have watched as computers have revolutionized the work place; giving us access to information never dreamed of by our parents generation. But we are on the fringe of a new world of technology where computers will do more than just automate; they will help us think in new dimensions. These new systems, called Artificial Intelligence (AI), literally use the creative capabilities of computers to think or take the

place of expert human intelligence.

AI is defined as "Behavior by a machine that, if performed by a human being, would be called intelligent (Turban, p.312)." Its goal, as postulated by German author Wolfgang Meyer is "to understand cognition, or to discover the representational and computational capacities of the mind (Meyer,123)." It is a field of computer science that is now moving from concept into commercial application.

An Expert System (ES) is a more general package that is developed for a specific set of users and incorporates "expert knowledge" to advise the user. Marvin Cetron predicts that ES will be in common use throughout manufacturing, energy prospecting, automotive repair, medicine, insurance underwriting and law enforcement and indeed, more and more organizations are incorporating this technology in their day to day operations.

ES and AI systems are interesting in their possible future impact. "Over 80% of the top 500 companies in the United States have explored using ES techniques (Harmon and Maus, 3)." And in the Persian Gulf War, all of the services fielded Expert or Artificial Intelligence systems. They ranged from "Help" systems like the Army's PRIDE (Pulse Radar Diagnostic Environment) to Command and Control (C2) systems like TOPPS (Tactical Operation Planning System). At the Tank and Automotive Command (TACOM), a powerful Cray supercomputer is being used to create simulated

vehicles that perform in simulated scenarios. Out of this AI environment comes new approaches to combat vehicle designs from the Dynamic Track Tensioning System (DTTS) on the M1A1 Main Battle tank, to wholly new combat vehicles that only exist in simulation.

The challenge of today is to design organizations that can make the best use of modern decision support systems and the information technology they require. This is not inherently easy. Organizations tend to resist change. Entrenched power centers fear the loss of power. These new information technologies provide amazing new power on the one hand yet tend to redistribute power on the other. Writing in his new book, Powershift, Alvin Toffler describes this as a "tsunami of corporate restructuring that will make the recent wave of corporate shake-ups look like a placid ripple (Toffler, 179.)." He is describing the impact that information technology will have on bureaucratic organizations; the greatest shift of power in business history.

WHAT ARE DECISION SUPPORT SYSTEMS AND HOW HAVE THEY CHANGED?

While anything that helps a decision maker arrive at a decision can be said to be a decision support system, the DSS concept as used here is more specific. It includes a concept of uniqueness that lets it stand apart from earlier views. Here are three different definitions of a Decision Support System.

1. Systems designed to support the decisions of managers. (Thierof, 26)
2. Interactive computer-based systems that help decision makers use data and models to solve unstructured problems. (Sprague and Carlson, 4)
3. Coupling the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions. It is a computer based support system for management decision makers who deal with unstructured problems. (Turban,8)

Each of these definitions has some key elements. Obviously number 1 is very basic, but it conveys the simplicity of the purpose of DSS. Numbers 2 and 3 convey other important aspects of what a DSS is; and what it isn't! A DSS is not needed for relatively simple decisions. It is needed for complex or unusual unstructured decisions. It is interactive; it requires the decision maker to participate in the process. And it is computer-based. The last part is important because it is the computer-based aspect of DSS that allows us to quickly sensitize our decisions.

The computer based DSS not only allows us to array many different aspects of a problem, but it also allows us to place different weights or values on those aspects, and give us a new

answer. In our earlier example of the two "Star Trek Captains," Captain Kirk is using data to support a decision, while Captain Picard is "interactively" using a computer based DSS to weigh different alternatives, sensitizing those alternatives to arrive at a quality decision.

A spreadsheet can structure a problem for us (Indeed many DSS use spreadsheets for inputs to the DSS) but it cannot allow us to sensitize among several variables to the degree a DSS can. In our definition of a DSS, a "spreadsheet" is a part of the DSS, but not the DSS itself. In fact, it becomes part of the Data Management System, one of the three components of the DSS. The other two components being Model Management and Dialog Management. Each of these three components provides a specific capability to the DSS, without which the DSS could not function.

The Dialog Management System is the component of the DSS that allows the decision maker to "talk" to the DSS. It has several styles including voice, mouse, or keyboard. While Captain Picard uses a voice activated Dialog Management System, most of us toil with "mice" and keyboards. The dialog function itself has three components, the action language, the presentation language, and the knowledge base. The first two are elements of the computer portion of the DSS and the knowledge base is what the user "brings to the table."

Turban describes the Model Management System as

> " a software system with the following functions: model creation, using subroutines and other building blocks; generation of new routines and reports; model updating and changing; and data manipulation (Turban,85)."

Sprague and Carlson provide a simpler definition, "The modeling component supports the activities that emphasize the design and choice phase (Spraque. p. 260)." This definition really gets to the heart of the matter because each DSS is unique. Remember, a DSS supports unstructured decisions, and by their nature, unstructured decisions are going to be different each time they are made. The modeling component therefore must allow the decision maker to design his or her own DSS based upon the unique requirements of the decision to be made.

If the modeling component of a DSS provides the capability to support the uniqueness of each decision, it is the Data Management component that provides the information upon which the sensitivity analysis can be performed. In a DSS, the data management function equates to the investigative portion of problem solving. The Database Management System of a DSS performs three functions, storage of data, retrieval of data, and control of data. Without timely data, a computer-based DSS is ineffective at best. The data base portion of the DSS is the

area where EDI has the most applicability.

The nature of DSS's has changed radically over the last fifteen to twenty-five years. High quality spreadsheet applications first began to appear in the late 1970s. The early leaders in this type of application, Visi-Calc and Lotus 1-2-3, provided managers an electronic capability that, by mid-1960's standards, was truly remarkable. As these systems became more complex and moved from mainframe to PC availability, the thought process of how to use the technology changed also. The marriage between electronic transmission of data and spreadsheet applications soon followed.

The principal difficulty with using the early spreadsheet systems for decision making was the input problem. Large, rambling spreadsheets required significant data input efforts. As we know from years of measuring such efforts, the number of data processing errors inherent in re-keying data into large spreadsheets limited their utility to non-sensitive transactions and decisions. It was necessary to find ways of capturing data at the source of the transaction and making those transactions available to other elements of the information system. Often this meant capturing and transmitting data from one location, perhaps quite remote, to the central computing site.

Typical of the progress of information technology, improvements in one area awaited improvements in other related areas.

No where was this more evident than in the development of Electronic Data Interchange (EDI). While spreadsheet applications evolved along their own separate track, the transfer of electronic information, which began in the trucking industry in the late 1960's with the development of the Transportation Data Coordinating Committee (TDCC), was moving along its own separate timeline. This early EDI predecessor was furthered in the early 1970s by the financial community who recognized the utility and profitability of electronic transfer of data and the Automated Clearing House Association was formed. These early efforts were the forerunners of Electronic Data Interchange. By virtue of their ability to move great quantities of data from one system to another, EDI systems became the natural partner of the evolving decision support system evolution. Let's look at EDI and see how it fits into a DSS.

ELECTRONIC DATA INTERCHANGE (EDI)

For a DSS to be successful, the data base upon which the decisions are made must be current and pervasive. EDI can provide both currency and pervasiveness in a data base. EDI is defined as the corporate-to-corporate exchange of business parties (and possible intermediaries) in a structured format (Masson and Hill,15)." It should be emphasized that EDI is an

exchange; not one way but two way and it is both an inter and intra exchange. EDI information can be stripped and used for many different purposes in many different data bases. And the structure of the exchange is also significant. EDI, in its highly structured format, allows organizations to make use of this information in many ways not thought of in early machine to machine transmissions. And both definitions stress the structure of the exchange. It is more revolutionary than evolutionary. Neal Baudette puts it succinctly, "EDI is the way to do business in an age that puts a premium on speed (Baudette,53)." That is why it fits neatly into the framework of an organization's Total Quality Management program. More on that later as I establish the link between DSS, EDI and TQM.

For example, a purchase order, in EDI format, is sent from organization A to organization B. In its most basic form this purchase order information is only of interest to the ordering component of A and the shipping component of B. However, the standardized format of EDI allows the same information to be made available to data bases in virtually every sector of each organization. Thus, in this case, the intermediaries could be warehousing, accounts payable, and senior management. A real world example of this type of integrated information sharing is Wal-Mart Department Stores.

Wal-Mart is a good example of a corporation that uses EDI in

a fully integrated system. Every transaction is fully dispersed to every conceivable decision maker. Using bar-coded transaction registers, every transaction is recorded and transmitted, real-time, to all departments and even to suppliers. Suppliers are therefore informed of sales and insure replenishment is accomplished without the need for separate purchase orders. Payment for supplies is made based on receipt of goods at the dock, not against completed or partial purchase orders. It is the constancy of the data, always in the same place, always with the same format, that makes EDI so versatile. Thus while an organization may choose to implement EDI for only a narrow range of electronic documents, or what Norman Barber calls "Technology Islands," (EDI World, Sept 91,5), it automatically receives the "spillover effects" of having that same information available for use in executive data bases, where EDI and DSS are most useful. Let's rehash a couple of key points before we go further.

1. A Decision Support System of the type we are considering is used for unusual or essentially unique situations.
2. Decision Support Systems require three modules, a dialog management subsystem, a modeling subsystem, and a data management subsystem.

Although DSS support unique situations, the data to support these

decisions is not. Since the time when a decision maker must act is invariably inopportune, the information to support the DSS must be continually gathered, analyzed, and stored for quick access. The data management subsystem provides this capability, but procedures to accumulate information must be firmly entrenched within the organization.

EDI can provide the timely data required by management to make these unusual or unique decisions. It does so by utilizing information generated by routine transactions and accumulated in data bases. EDI can support such data collection, and can do so without having the data re-keyed. This is another important benefit of EDI; it uses source data for updating management data bases without the expense and error generation by re-keying. Precisely, because it is management that can derive the most benefit from EDI, it is management that must take the leading role in installing EDI in an organization.

While it is true that any major organization change must be supported from the top, EDI is unique in that it's most relevant benefits come from not consigning it to the MIS support groups. EDI is a weapon in a fast moving world of technology and innovation. It is a management tool of unparalleled proportions. It offers management an opportunity to re-engineer the organization.

ORGANIZATIONAL RENEWAL, RE-ENGINEERING, AND TOTAL QUALITY MANAGEMENT

Here are three additional concepts that need to be weaved into the underlying premise of this paper. If we are to make better decisions i.e. decisions that are based on higher quality information and sensitized for different variables, we must use the technology available to its highest levels. The premise here is that we cannot do that without first restructuring the organization so that we can properly use the information the new technology will generate. Total Quality Management, organization renewal and reengineering work do not mean exactly the same thing, but are all closely related.

After World War II, United States' industry became complacent about quality. Without competition, our industries had no prerogative to improve. When U.S. industry leaders would not listen to what he had to say about quality, W. Edwards Deming took his "revolutionary" views to Japan where he found a willing audience. Now, U.S. companies have come back to Total Quality Management, TQM, and embraced it with open arms. Since this is not a paper on TQM, but information technology, we won't dwell on all that TQM has to preach. But there are several aspects of TQM that depend on information technology.

Statistical Process Control (SPC) is often referred to as

one of the main focuses of TQM. Basically, a quality product is achieved through continuous improvement of processes. Both Deming and Dr. Joseph Juran stress management by interpreting data and using feedback loops.

Reengineering work is TQM raised to a higher level. If TQM works on the margins (continuing improvement in systems and processes) then reengineering is the obliteration of some of the processes themselves. If TQM is about substituting automated process controls in place of unstructured, processes, then, reengineering radically redesigns our processes to make dramatic improvements in their performance. And superimposed on both techniques is the concept of organizational renewal.

> "No organization," writes author Robert H. Waterman, "can strive for excellence, or even attempt to improve, without the ability to renew (Waterman,xv-ii)."

Organization renewal is about people. Empowering employees is the method and, I believe, information technology gives organizations the ability to renew. Within the scope of organization renewal, the most dramatic source of improvement is reengineering the processes. Once reengineered, TQM provides the long term vision that allows for the never ending improvement that produces

customer satisfaction.

Organization renewal has really been around for a long time. And TQM, in the personage of Dr. W. Edward Demings, has been a successful management technique since the mid-1950s in Japan. But reengineering could only be successful only in an age where visionary managers can dream to restructure organizations in wholesale terms; the notion of "discontinuous thinking - of recognizing and breaking away from outdated rules and fundamental assumptions that underlie operations (Hammer,107)." The reason why these visions could not be implemented earlier is because the information technology needed to make them happen was still years away.

While we can only imagine the kinds of change that new Artificial Intelligence programs will enable, we have now management philosophies and information technology available to 1) Renew our organizations, 2) Reengineer our processes, and 3) Implement Total Quality Management to continuously improve those reengineered processes. But without enlightened leadership, none of these will be of use.

LEADERSHIP AND DECISION MAKING

Vision is a common thread in all three management philosophies. Vision, more than any other quality, is what separates

leaders from managers. Waterman equates successful renewal as "informed opportunism," and "renewing companies treat information as their main strategic advantage and flexibility as their main strategic weapon (Waterman,7)."

This is the tie between the earlier technical discussions and the just completed philosophical discussions of management philosophies. To be a leader, to define a vision, to set direction requires information. And not just volumes of information! What is clearly required is a support system, a decision support system that uses the most current information available to help the leader/manager to visualize the future and make quality decisions. There is no perfect information system but there are now many software systems which can aide leaders in their never ending quest.

There are two categories of Decision Support Systems. The first category relates to those unique decisions which are made just once and require very specialized DSSs. Because of their nature, these tend to be "throwaway" systems. Since the decision itself tends to be unique, the DSS also tends to be unique. There is a basic problem with these DSSs. The decision maker must participate either wholly or partially in the development of the system. Unless the decision maker is a programmer, he or she needs assistance in developing the DSS. New off-the-shelf systems such as "Expert Choice" or "Decision Analyst" can be of

significant help in designing a unique DSS. These types of DSSs generally allow a user to test outcomes by varying the sensitivity of certain criteria. In this case, the decision maker acts as the "expert" analyst.

So, there are systems to use, philosophies to embrace, and technologies to explore. We are given to believe that organizations must renew themselves to continue their existence. Within renewal there are degrees of change; marginal change ie. TQM, and radical change ie. reengineering. And there are decision support systems for managing change, for implementing a vision. Let's now look at one typical public sector organization and see where it stands.

A CASE STUDY IN ORGANIZATIONAL INFORMATION TECHNOLOGY

If we try to put all this into a framework for future visionaries, we arrive at today's biggest management challenge. How to use the technology we now have to keep organizations vital, renewed and able to compete at the dizzying pace of change that exists in the world today. As we have seen, all organizations must renew themselves or risk becoming extinct. For some, as those in government, the risk is less because the government normally does not go "out of business." Just the same, for small agencies with limited public support, the risk is real and often

the prospect of being subsumed by a larger agency or broken up into many pieces, then distributed among many agencies, comes dangerously close to becoming reality. This happened to the Coast Guard early in the first Reagan Administration as a result of the Grace Commission Report. The prospect of that reoccurring always looms in the minds of Coast Guard officers who make decisions about the future course of that organization.

In 1989 the Coast Guard began to embrace Total Quality Management. After months of executive level discussions, the Commandant issued the Coast Guard's Vision Statement. Structure and training soon followed. So in the Coast Guard, we have a vision which tells us where we are going and a management philosophy, TQM, which tells us that we are going to be a customer focused organization; and we will examine our processes and make continuous improvement to them. In today's environment, that will not be enough. The following specific courses of action need to be considered:

1. The Coast Guard must reexamine its processes and eliminate unnecessary work where it can eg. re-engineer the process.
2. Eliminate middle management where possible. This follows the lead of our private sector which restructuring its workforce to eliminate unnecessary layers of management.

3. Make use of EDI principles to eliminate all duplicate data entry throughout the service.
4. Use a combination of decision support systems, including Artificial Intelligence and Expert Systems to replace, where possible "human experts" with user friendly software systems.

The whole thrust behind this process should be to place every available person at the point of the service we deliver and not at the tail. The interesting thing about this is that it can be done.

The Coast Guard already has many of the required elements in place. First, the Coast Guard has a common hardware/software suite throughout the organization. Now in its second generation of HW/SW, the CG standard workstation is a prerequisite to establishing source data automation. The current system uses UNISYS workstations and the Burroughs Operating System, or BTOS. The bundled software package which exists throughout the CG includes a word processing, spreadsheet, graphics, and art designer package. Contract add-ons allow for hardware upgrades to accomplish many other standard processing packages for the knowledge worker such as personnel, finance, and many operational systems. It is this standardization that will allow EDI to become a reality.

The CG's financial package, called LUFS for Large Unit Financial System, provides a unique stand alone capability for handling supply and financial management at the local level,while providing an integrated capability for providing the detailed purchase order (PO) information necessary at a central location for EDI transmission of the PO to participating trading partners. This same central location has the capability to reformat that same information and release it to other financial systems.

The second requirement for source data automation (SDA) is a series of local area networks and a wide area network for telecommunicating the data once recorded locally. The CG is also well positioned to move data. Local area networks exist throughout the organization and feed information to a CG leased WAN. Source data information has mobility within the CG.

The third requirement for use of EDI in a DSS is a central data base management system (DBMS) to synthesize incoming data and transform it into information. The CG has a basic Executive Information System (EIS) which has been under development for several years. It is operational only in a limited sense.

The last requirement for effective use of EDI within a DSS is the vision to make it happen. Here the CG falls short. While the Commandant has published a Coast Guard Vision Statement, there is nothing in this statement that supports Information Technology in general, or EDI in specific. It is clear from

every example cited in this paper that executive leadership is required for organization renewal to become a success. As David Hough stated in the conclusion to his article,

> "Who, then is responsible for the implementation of EDI and Timeless Business? The answer is those who are responsible for the bottom line. Because it touches the entire organization, EDI requires the direction and commitment from the top down to make those changes. It takes vision and power that is available only from senior management. But his can easily be remedied (Hough, Float)."

The Department of Defense is doing just what Hough expects. The Corporate Information Management program, under the direction of Paul Strassman, is doing for DOD what needs to be done for the Coast Guard. In DOD the program is massive, and pervasive. It has a broad vision for the future. And CIM offers an interesting contrast to the Coast Guard. In DOD there are problems of cross service interconnectivity. In Coast Guard there are no such problems. In DOD there are incompatible system problems. In Coast Guard there are none. And when it comes to the use of information technology, in DOD there is vision; in the Coast Guard there is none. And while the jury is still out on the success or failure of CIM, it is clear that without such an effort, the organization it supports will not have a fighting chance to reengineer its business practices and survive.

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